REMARKS

The applicant's undersigned counsel thanks Examiner Kuhns for his continued careful and thorough examination of the present application. Claims 42 and 56 have been amended for clarity, and also to specify the liner is one piece. The 'one piece' limitation was previously found in dependent claim 43, and therefore has already been searched. Other claims have been amended to correct their dependency. No new matter has been entered. Claims 43 and 45 have been canceled without prejudice.

The Section 112, second paragraph rejection from the previous Office action has been maintained. The Examiner's position is that it is not clear what qualifies as "effective attenuation" within the metes and bounds of the claims. Respectfully, claim 42 (and now 56) states the semi-rigid viscoelastic foam is effective to attenuate an impact force to "dissipate a substantial portion of said impact force away from a localized region of impact." Thus, it is clear that "effective attenuation" according to these claims means that the recited foam will be capable to dissipate *a substantial portion* of the impact energy away from the localized point of impact across the entire claimed velocity range. This is to be distinguished from expanded polystyrene ("EPS"), for example, which is effective to dissipate a substantial portion of impact energy only at higher impact speeds (e.g. 4-7 m/s). At slower speeds, EPS is so rigid that it acts essentially as a fixed solid, transmitting substantially all of the impact force through to one's head.

On the other hand, conventional foams that are effective to absorb and dissipate a substantial proportion of impact energy at slower speeds substantially crush at higher ones, thereby transmitting substantially all of the impact energy. According to the present claim limitation, the recited semi-rigid viscoelastic foam has struck a balance in terms of rigidity and elasticity characteristics so that it will be effective to divert "a substantial portion of said impact force away from a localized region of impact" for *both* high- and low-speed impacts, e.g. *anywhere* in the claimed range of 2-7 m/s. This is believed to be sufficiently clear to delineate the scope of the claims; i.e. a foam that will provide effective diversion of a substantial

proportion of impact energy from the point of impact at both low and high speeds. In other words, at high impact speeds, the foam provides similar energy-absorption characteristics to a rigid foam, like EPS. At the same time, at low impact speeds the foam provides far greater energy absorption than any conventional rigid foam (like EPS) could. It is submitted, therefore, in view of this background and the specification (e.g. paragraph [0049] as filed), the current claim scope is clear. However, to emphasize the relationship between "effective attenuation" and the resulting dissipation of impact force, the claims have been amended to state that the foam is effective to attenuate impact force anywhere within the recited range, to "*thereby*" dissipate a substantial portion of the impact force. From this, it is clear that "effective attenuation" refers to the capability to dissipate a substantial portion of impact force across the entire recited range of 2-7 meters per second, which clearly distinguishes prior art foams, which are geared toward only one end of this range, and usually the higher end (such as EPS or EPP used in modern bicycle helmets).

Claims 42 and 56 have been rejected under 35 USC § 103(a) as being obvious over Tirums in view of either Moore, III ("Moore") or Bell et al. ("Bell"). Tirums does not disclose a semi-rigid viscoelastic foam, and the Examiner has relied on Moore or Bell to supply this teaching. However, neither reference discloses or implies that its foam provides effective impact force attenuation (i.e. dissipate a substantial portion of the impact force) across the *entire* 2-7 m/s range as presently claimed. The Examiner has explained that both references "teach the inclusion of a viscoelastic layer in a helmet liner position." Office action, p. 2. The Examiner further states that Moore "explicitly teaches that the viscoelastic layer may be semi-rigid." He also has taken the position that the viscoelastic foam in Bell would have "at least some rigidity," which appears to be an inherency argument.

Respectfully, the Examiner's positions regarding the teachings of Moore and Bell are flawed, because even assuming them to be correct they do not require, conclusively as is necessary for an inherency-based rejection, that the disclosed foams provide "effective" attenuation of impact force across the entire 2-7 m/s range. It is believed that some confusion,

and the present art-based rejections, may have arisen out of the apparent misunderstanding regarding the scope of that limitation, as set forth in the last Office action. In view of the foregoing explanation regarding that limitation, as well as the associated claim amendments to make it clearer, it is believed to be clear why the rejections based on Moore and Bell should be withdrawn. Neither reference discloses or gives any reason to expect that its foam will behave (provide effective attenuation across the entire impact-velocity range) as claimed.

The fact that the references may disclose viscoelastic foams, or even semi-rigid viscoelastic foams (which is not conceded), does not imply that those foams ***also*** have the unique characteristic to provide the claimed impact-force protection across the *entire* recited range. For the Examiner's convenience, an explanation of the foam properties known as elasticity and rigidity (which are distinct) is provided below to help explain why a semi-rigid, viscoelastic foam described in a reference does not necessarily meet the impact force-attenuation limitation recited in the claims.

Viscoelastic foams are a class of foams that exhibit aspects of both viscous and elastic character. Foams in this class are deformable or deflectable based on either a dynamic impact event or a quasi-static compression event, but there is no permanent deformation once the external stress or force causing the deflection is removed. However, the rate of recovery of viscoelastic foams is not instantaneous and includes a time dependent component based on the foam's unique morphology. In simpler terms, there is a prolonged or extended process of recovery after the external compression or impact load has been removed, the duration of which is based on the foam's morphology, which is determined based on its unique composition. To better understand viscoelastic foams, a brief discussion of purely elastic and purely viscous foams is provided below.

For a purely elastic foam, all the energy of loading or compression (i.e. the energy required to compress or deflect the foam) is stored in its compressed or deflected state, and is returned by the foam once the load has been removed. Another way to think of it is that the foam essentially pushes back with the same force (equal and opposite) that is acting against and

tending to compress it, and it continues to push back, even under static conditions, with the same force until the load is removed. The displacement of an elastic foam exhibits an immediate (non-time dependent) response in phase with the load or strain.

Conversely, for a purely viscous foam, no energy is returned after the load tending to compress the sample is removed. More simply, a purely viscous foam does not "push back" against the loading stress except to the extent based on the foam's "rigidity" (described below). In other words, a viscous foam does not exert any rebound force against compression under static conditions (i.e., once the object supplying the compression force has come to a stop in contact with the compressed foam). Instead, all the energy imparted to the foam to compress it is converted into internal energy or heat based on internal frictional losses from the viscosity of the foam material.

All foams that are neither purely elastic nor purely viscous are classified as "viscoelastic" foams. In a viscoelastic foam, some of the loading energy (stress) from an external impact is returned by the foam following removal of the external load, and the remainder is dissipated through conversion to internal energy or heat from internal frictional losses based on the material's viscosity. The proportion of the loading energy (stress) that is lost in this fashion, and not returned by the foam, is called hysteresis. A typical hysteresis loss for a viscoelastic foam is greater than 60%, and can be as high as 80% or more, of the loading energy. The high hysteretic characteristic of viscoelastic foams makes them desirable for applications requiring low rebound rate and high-energy absorption. <u>From the foregoing, it should be evident that viscoelasticity refers to the manner and mechanism through which a foam stores and/or dissipates the energy required for compression</u>.

Another material property of foams is rigidity. <u>The rigidity of a foam is a measure of the foam's static hardness, sometimes called its "durometer" or modulus. More specifically, rigidity refers to the qualitative hardness or resistance to deflection of a material from a static state, such as a foam, based on an external load</u>. The rigidity of foams can be understood through analogy to the rigidity of objects of more common experience. For example, a rubber ball (such as a

racquetball) is less rigid than a baseball, and a baseball is less rigid than a bowling ball. A foam that is truly rigid cannot be deflected without destruction of the foam. In practice, very few if any foams are truly 100% rigid, as all (or most) foams can be deflected to some finite degree based on a quantifiable modulus of elasticity or "Young's modulus." But for practical purposes, a foam that will break rather than yield (bend or deflect but remain structurally intact) to any significant degree on being loaded beyond a threshold value is considered a rigid foam. A good example of a rigid foam is expanded polystyrene commonly found in bicycle helmets. Expanded polystyrene is very rigid; i.e. it is not susceptible to being compressed or deflected to any significant degree, and if loaded beyond a threshold value it will irreversibly, destructively crush or break rather than bend.

Conversely, a truly flexible (i.e. non-rigid) foam will bend or deflect readily on application of an external load. Again, in practice few (if any) foams are truly 100% flexible, as most (or all) foams will tend to resist deflection to some finite degree, at least from static inertia or the foam's elasticity. But, for practical purposes, a foam that deflects or compresses readily in response to a load is considered a flexible foam.

A "semi-rigid" foam is one that is neither flexible nor rigid in practical terms. Instead, a semi-rigid foam exhibits substantial resistance to deflection based on an external load, and may nondestructively yield (bend or compress) at some threshold loading value. Under normal conditions where a semi-rigid foam will encounter ordinary loads (below a threshold loading value), the foam will behave essentially as a rigid solid. But the semi-rigid foam will be nondestructively deflected or compressed in response to an external load above the threshold value. As will be understood by persons having ordinary skill in the art, the threshold value of external loading force required to cause a semi-rigid foam to deflect will be significantly greater for a high speed, dynamic impact than for a very low speed impact or a static (or quasi-static) load, due in part to the static inertia of the semi-rigid foam material.

As is understood in the art, the degree of rigidity of a foam is ***related*** to the foam's viscoelasticity, but it is, nonetheless, an independent property. For example, a highly resilient

("elastic") foam will return all the energy stored in the foam that was required to deflect it once the external load has been removed. But such a foam can be, independently, either a flexible foam, a semi-rigid foam or (rarely) a rigid foam depending on its resistance to being deflected. Conversely, a low-resilient or "viscoelastic" foam will recover in a time-delayed manner and return only a portion of the energy required to deflect it based on the hysteresis function of the foam. But, such a foam also can be, independently, either flexible, semi-rigid or rigid depending on its resistance to being deflected from a static state.

The specific chemical components that go into a foam are outcome-determinative for the physical and behavioral characteristics just described for the resulting foams. In addition to, e.g., polyol(s) and polyisocyanate(s) for polyurethane foams, all foam formulations may include blowing agent(s), catalyst(s), chain extender(s), crosslinker(s), pigment(s), surface active agent(s), filler(s), flame retardant(s), etc. Each component can affect the characteristics of the final foam in an unpredictable way based on its effect on the foam's morphology and physico-chemical structure, which cannot be specified *a priori* and often defies explicit characterization even after the foam is made. For example, for polyurethane foams the polyols can be polyether or polyester types. For polyether foams the initiator molecule and the alkyleneoxides used for chain extension and tipping are extremely important in determining the solubility, compatibility, reactivity, surface tension, stability and function of the reacting polyol. The alkyeneoxides make an important contribution toward determining the physical characteristics of the resulting polyurethane foam, i.e., the foam's morphology, which is largely determined by the molecular weight, structure and reactivity of the polyol(s) in addition to other factors. The morphology determines the type and amount of important physical interactions in the resulting foam. These interactions include the extent of hydrogen bonding in the foam and the hard block/soft block distribution in the foam, which contribute to the foam's rigidity. Importantly, the glass transition temperature, the foam's rigidity and its viscoelasticity all are determined by the foam's morphology in a largely unpredictable way.

If the components of two foam compositions are not precisely identical, then the resulting foams will have different physical properties. Two foams may both be characterized as viscoelastic foams, or even as semi-rigid viscoelastic foams, and still differ greatly and unpredictably in terms of the individual behaviors in the face of an impact load of variable degree (e.g. across the entire 2-7 m/s range now claimed). For example, two semi-rigid, viscoelastic foams can vary greatly in their density, tensile strength, compression set, impact character, tear strength, compression hardness, etc. *Although the foams may share some common properties, e.g. they both may exhibit some resistance to initial deflection as well as slow recovery and thus high hysteresis during a compression cycle (which is why the are classified as semi-rigid, viscoelastic foams), they can diverge greatly in terms of other physical properties, and in their impact-absorption behavior across a range of different loads*. As explained above, this will most certainly occur unless two foams have precisely the same composition.

For the foregoing reasons, it should be clear that even assuming the Examiner's characterizations of Moore and Bell to be correct, a semi-rigid, viscoelastic foam in the prior art does not *necessarily* anticipate or render obvious the claimed foam, which provides effective impact-force attenuation across the entire 2-7 m/s range. Absent some *reason* to presume otherwise, such as a specific teaching in the reference, it is improper to assume Moore's or Bell's foam will behave as presently claimed just because that foam may also be a semi-rigid, viscoelastic foam.

For the foregoing reasons, it is respectfully submitted that all of the rejections have now been overcome. It is also submitted, respectfully, that the amendments to the claims herein do not substantially alter their scope, and should not necessitate a further search. Accordingly, entry and consideration of this Amendment after final is respectfully requested.

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Respectfully submitted,

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